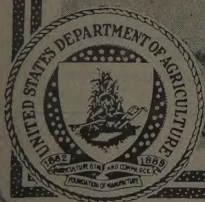


U. S. DEPARTMENT OF
AGRICULTURE

FARMERS' BULLETIN No. 1691

HOW TO CONTROL
GRASSHOPPERS
in CEREAL and
FORAGE CROPS



1932

ALTHOUGH the farmer usually does not notice grasshoppers until they have reached a considerable size, they begin to injure his crops soon after they hatch. They should therefore be detected and combated while they are young and small, so that time, labor, and material, as well as crops, may be saved.

Destroying grasshopper eggs by fall plowing, disking, or harrowing is recommended where such destruction is practicable.

Applying poisoned-bran mash is the most practical means of controlling grasshoppers. The poisoned mash should be put out usually between 6 and 10 a. m., or as soon after sunrise as air temperatures reach 70° to 80° F. At these times the grasshoppers are on the ground doing their first feeding of the day. Exact temperatures at which maximum feeding occurs differ with the locality and the species of grasshoppers. The mash should not be put out while the temperature is below 70° or above 85° or during cloudy or inclement weather.

In mixing and distributing the poisoned mash care should be taken to prevent injury to persons or farm animals.

The best results can be obtained when all the farmers in a community cooperate.

This bulletin is a revision of and supersedes Farmers' Bulletin 747, Grasshopper Control in Relation to Cereal and Forage Crops. V. 241.

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HOW TO CONTROL GRASSHOPPERS IN CEREAL AND FORAGE CROPS

By J. R. PARKER and W. R. WALTON, Senior Entomologists, and R. L. SHOTWELL, Assistant Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology

J.M.R.

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GRASSHOPPERS have always been among the principal insect enemies of agriculture. Serious outbreaks still occur over large areas at irregular intervals, and the aggregate annual loss due to grasshoppers even during years not marked by outbreaks is sufficient to class these insects as a major pest.

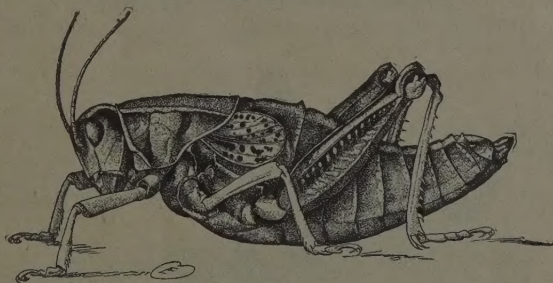


FIGURE 1.—Southwestern lubber grasshopper. Adult female.
Natural size

PRINCIPAL KINDS OF INJURIOUS GRASSHOPPERS

Many kinds of grasshoppers injure grains, grasses, and forage crops throughout the United States. The most important are the southwestern lubber, the differential, the 2-striped, the lesser migratory, the red-legged, the Carolina, and the pellucid or clear-winged grasshoppers.

The southwestern lubber grasshopper (*Brachystola magna* Gir.) (fig. 1) is very large, usually pale green, speckled, and marked with pink and brown, and is wingless throughout its entire life. This species lives in the semiarid regions of the Southwest. It sometimes

becomes injuriously abundant on the cattle ranges and dry farms of New Mexico and Arizona, but is found throughout the Great Plains area from Wyoming and South Dakota to New Mexico and Texas.

The differential grasshopper (*Melanoplus differentialis* Thos.) (fig. 2) is usually yellowish, with clear, glassy hind wings, and

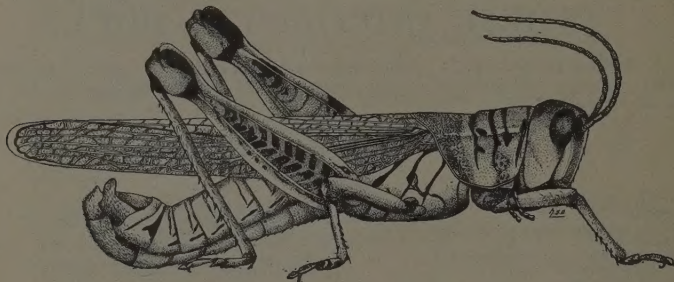


FIGURE 2.—Differential grasshopper. Adult male. Twice natural size

averages nearly $1\frac{1}{2}$ inches in length. Its hind legs are usually distinctly marked with yellow and black, the color arranged in chevron-shaped bars on the sides of the thighs. It is found throughout nearly the entire United States, although rarely in the Atlantic States. This grasshopper is chiefly injurious in the Middle Western and Southwestern States.

The two-striped grasshopper (*M. bivittatus* Say) (fig. 3) is compact and yellowish, bearing two yellow stripes from the forehead

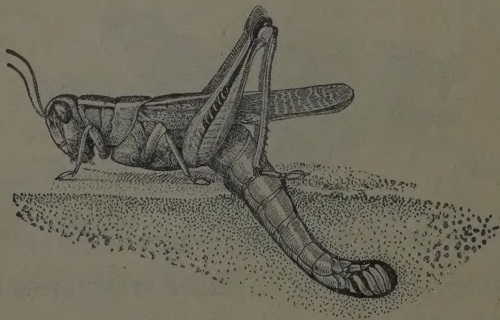


FIGURE 3.—Two-striped grasshopper laying her eggs. Natural size

down each side of the otherwise brown back, and having nearly colorless hind wings. It ranges from 1 to $1\frac{1}{2}$ inches in length. This species is found from southern Canada to Mexico, except in the South Atlantic States.

The lesser migratory grasshopper (*M. mexicanus* Sauss.) (fig. 4) is reddish brown, bearing a distinct patch of black on the neck or collar and averaging about 1 inch in length. Although compara-

tively small, it is a strong flier and sometimes does immense damage to crops. It is found throughout nearly the entire United States, but is chiefly injurious in States west of the Mississippi River.

The red-legged grasshopper (*M. femur-rubrum* De G.) (fig. 5) is one of the most widely distributed of all the injurious species.



FIGURE 4.—Lesser migratory grasshopper. Adult male. Twice natural size

It is small, reddish brown above and yellow beneath. Its legs are partly tinged with a bright red and its hind wings are colorless. It is found in considerable numbers throughout the entire United States, southern Canada, and northern Mexico.



FIGURE 5.—Red-legged grasshopper. Adult male. Twice natural size

The Carolina grasshopper (*Dissosteira carolina* L.) (fig. 6) is of medium to rather large size, and is usually of a plain pepper-and-salt color, sometimes varying from gray through yellowish to a distinctly reddish color depending upon the soil upon which it is found. Its



FIGURE 6.—Carolina grasshopper. Adult male. Twice natural size

hind wings are nearly black, margined with yellow. Thus it is inconspicuous while sitting upon the ground but catches the eye immediately upon taking flight. It is very widely distributed throughout the entire United States.

The pellucid or clear-winged grasshopper (*Camnula pellucida* Scudd.) (fig. 7) is small and its hind, or true, wings are clear or pellucid while the front wings are distinctly blotched with brown. It is distributed throughout the Northern States from the Atlantic to the Pacific, and is at times one of the most injurious species in the United States.



FIGURE 7.—Clear-winged grasshopper. Adult male. Twice natural size

Grasshoppers, both young and old, injure crops in but one way, by gnawing and devouring them wholesale. Where very numerous they have been known to consume almost every green thing in sight (fig. 8), even eating the bark on the tender twigs of trees and gnawing the handles of hoes and rakes in order to secure the salt left there by perspiring hands.

CONDITIONS FAVORABLE TO OUTBREAKS OF GRASSHOPPERS

It is generally believed that dry, warm weather is favorable for grasshoppers and it is known that the most severe outbreaks have occurred either during or following periods of drought. Wet weather is unfavorable and great numbers of grasshoppers often die from disease under such conditions. Many years ago, attempts were made to control grasshoppers by spreading disease among them, but it was found that both fungous and bacterial diseases developed of their own accord during wet weather but always failed to thrive under dry conditions. Cool weather during the egg-laying period decreases the number of eggs laid. Winter temperatures have little effect upon grasshopper abundance.

LIFE HISTORIES AND DEVELOPMENT OF GRASSHOPPERS IN GENERAL

The life histories of the various species of injurious grasshoppers are quite similar. The eggs are usually deposited in the soil, inclosed in sacs, or "pods," formed of a glutinous substance furnished by the female. The grasshopper thrusts her abdomen, which is capable of considerable extension, into the soil (fig. 3) and starts laying her eggs at the farther end of the tunnel thus formed, which is then filled with eggs and sealed. One grasshopper has been known to deposit as many as 441 eggs.

Egg laying usually takes place in late summer or early fall and the young grasshoppers emerge the following spring. In some of the Southern and Southwestern States the young grasshoppers may emerge as early as February, but in the North the eggs usually do not hatch until May or June.

In contrast to many other injurious insects, grasshoppers when newly hatched closely resemble their parents, except that they lack wings. There is no grublike larval stage, nor is there any resting or

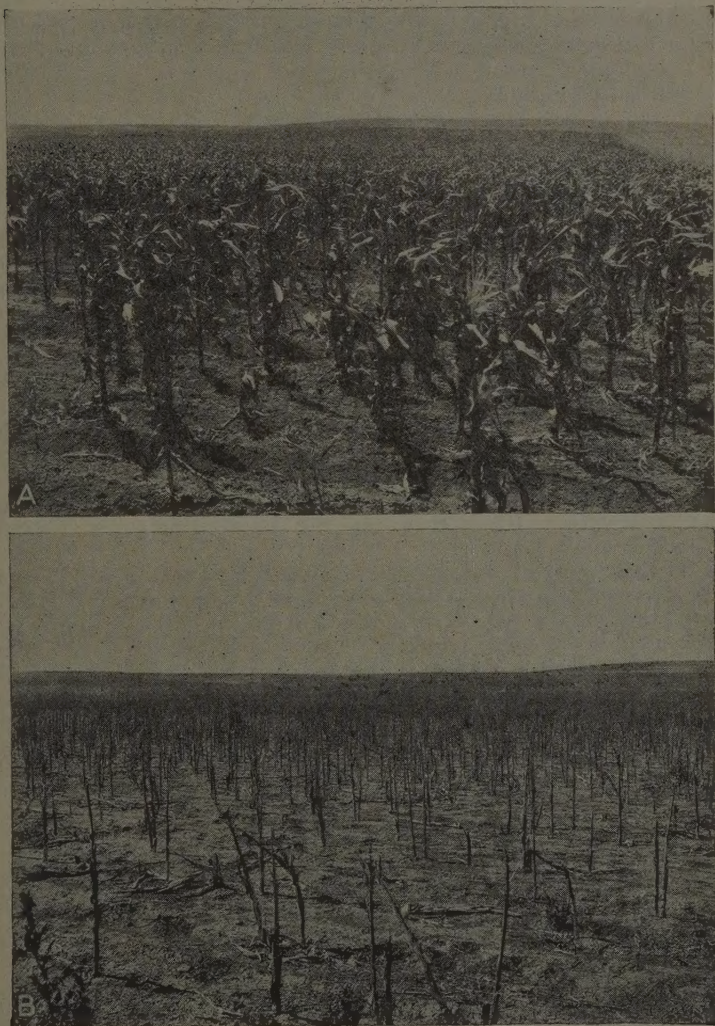


FIGURE 8.—These photographs show how grasshoppers may ruin corn. In the upper picture an army of adult differential and 2-striped grasshoppers is entering the corn at the edge of field shown in the foreground. The lower picture shows the same field a few days later after the grasshoppers have passed through it. In many cornfields in the immediate vicinity every stalk was devoured to the very ground

true pupal stage, such as that of butterflies and moths. The young grasshoppers are active and able to hop almost immediately upon

emergence from the eggs. They require from 40 to 60 days to grow into maturity and develop wings. During this time they shed their skins five or six times. The cast-off skins are often mistaken for dead grasshoppers and frequently are the basis of mistaken reports that grasshoppers are "dying by the millions." The appearance of wings, except in the wingless species, marks the final stage of growth, and the grasshopper is then ready to mate and reproduce. There is only one generation a year.

NATURAL ENEMIES

Several kinds of parasitic 2-winged flies deposit maggots upon grasshoppers in their mature or nearly mature stage. Among the most important of these is a flesh fly, which has been observed to deposit live maggots upon the grasshoppers while they are in flight. The maggot devours the internal portions of the grasshopper's body and soon causes its death. Robber flies feed very largely upon young grasshoppers, grasping them with their long, stout legs, thrusting their strong beaks through the body walls of the grasshoppers, and sucking out the liquid contents of the bodies. Several kinds of digger wasps kill or stupefy grasshoppers by stinging and then drag them into their underground nests. The wasp then lays an egg upon the body of the grasshopper, which subsequently becomes food for the newly hatched grub. A number of blister beetles are known to prey in their young stages upon the eggs of grasshoppers, but as the adult beetles are sometimes quite injurious to potatoes, beans, and other cultivated plants, they can not be considered as entirely beneficial.

The Bureau of Biological Survey has found that birds play an important part in the natural control of grasshoppers. All birds except the strictly vegetarian doves and pigeons feed on grasshoppers and destroy large numbers of them, but they can not be expected to prevent outbreaks. It has often been asserted that the reason grasshoppers are so abundant at the present time is that game birds are less numerous than formerly. It should be remembered, however, that the worst grasshopper outbreaks in the history of American agriculture occurred in the Great Plains region 50 to 60 years ago when game birds were far more plentiful than they now are.

CONTROL MEASURES

Two principal methods of control have been found to be of practical value in combating grasshoppers in this country: (1) Destruction of the eggs; and (2) use of poisoned baits.

DESTROYING GRASSHOPPER EGGS

Where grasshopper eggs are laid in ground that can be economically plowed or harrowed, great numbers of them can be destroyed by these operations. The lesser migratory grasshopper, when abundant, lays great numbers of eggs around the roots of the current year's grain crops. Plowing and packing the stubble fields either in the fall or early in the spring delays the hatching of the eggs and prevents the young grasshoppers from reaching the surface. The 2-striped and the differential grasshoppers most often lay their eggs in sod land and

weedy ground around the edges of forage and cereal crops. Plowing or disking headlands and ditch banks may destroy great numbers of the eggs. The clear-winged grasshopper concentrates its eggs in overgrazed pastures, wild-hay meadows, and in sod land along roadsides. To plow or disk such land is expensive and ruins it for grass production. Under such conditions egg destruction becomes impractical.

When land that contains grasshopper eggs is plowed, the soil should be turned to a depth of at least 6 inches; it should then be harrowed or packed. If the job is well done, the young hoppers hatching from the eggs are not able to reach the surface. Cultivating with a disk harrow breaks open many of the egg pods and brings them to the surface, where they dry out and die. Several diskings about 10 days apart are necessary to bring most of the eggs to the surface. Disking during warm, dry weather in September and October is more effective than disking in the spring.

USING POISONED BAIT

Use of poisoned-bran mash has proved to be a simple, reliable, and cheap method of destroying grasshoppers. This mash has been applied with signal success in many portions of the United States.

MATERIALS RECOMMENDED

In obtaining a proper formula for the mixture many substances have been tried, and the following formula is now recommended:

Coarse bran-----	pounds--	100	J. E. Con. En.
Crude arsenic-----	do-----	5	paper 3.
Cane molasses-----	gallons--	1½	
Water-----	do-----	10-12	

Bran.—Coarse wheat bran should be used if possible. Bran containing shorts or flour should be avoided, as it causes the mash to gather in lumps which are very hard to break up and which, when scattered in the field, are unattractive to the grasshoppers and dangerous to livestock. The use of good coarse bran greatly reduces the labor of mixing and such bran should be insisted upon where large quantities are to be prepared.

Arsenic.—Finely powdered crude arsenic obtained from smelters is recommended. It is more bulky and more finely divided than the more expensive refined white arsenic and therefore mixes better with the bran. Two quarts of liquid sodium arsenite (4-pound material) or 2½ pounds of dry sodium arsenite can be substituted for the 5 pounds of crude arsenic in the formula. Paris green can also be substituted, but is much more expensive. Calcium arsenate, sodium arsenate, or lead arsenates should never be used.

Molasses.—Only the low-grade cane molasses known as blackstrap is cheap enough to warrant its use. Molasses from the grocery store purchased in gallon lots is usually too costly and is no more attractive than the cheaper grade. Beet molasses has been used with good results against the clear-winged grasshopper, but with different species it has acted as a repellent. It is therefore recommended for use only where the clear-winged grasshopper is dominant.

J. E. Con. En.
paper 3.

J. E. Con. En.
paper 2.

OTHER MATERIALS SOMETIMES ADDED TO THE BAIT

Amyl acetate.—This material is a liquid with a banana-like odor and has been used at the rate of 3 ounces per 100 pounds of bran to replace the citrus fruits formerly recommended. It has been used to advantage when feeding conditions for the hoppers have been unfavorable.

Salt.—Cheap, granular dairy salt sometimes adds to the attractiveness of the bait. However, where the soil is alkaline it has proved to be a distinct repellent and is not recommended for general use.

Sawdust.—In some sections where its addition cheapens the bait, sawdust mixed in equal parts by weight with the bran has been



FIGURE 9.—Mixing poisoned-bran bait. The water, arsenic, and molasses are being mixed in the large can in the center of the picture¹

used with good results. It has a tendency to cut down the effectiveness and should only be used if sufficient bran can not be obtained at a reasonable price.

Good results have been obtained by using a mixture of bran, arsenic, and water, and if it is not possible to obtain the molasses or other attractants it is far better to use the poisoned-bran mash without them than to delay until the crop has been seriously damaged.

MIXING THE BAIT

The bran is spread out on a tight floor or in a wagon box or similar container (fig. 9) to a depth of 8 to 10 inches. The required quantities of water, arsenic, and molasses are mixed thoroughly in a large can or barrel. This mixture is then splashed over

¹ Figures 9 and 10 were furnished by the courtesy of C. J. Drake of the Iowa Agricultural Experiment Station.

the bran, about 3 gallons at a time, and the bran is worked into a mash by turning it over with a scoop shovel, potato fork, or garden rake. When either crude arsenic or Paris green is used, the liquid must be stirred constantly, as otherwise the poison soon settles out. Continuous stirring is not necessary when dry or liquid sodium arsenite is used, as this compound dissolves quickly in water. About 200 pounds of bran is all that can easily be mixed in a wagon box at one time, but on a floor where there is plenty of room about 500 pounds can be handled. Good results depend on mixing the mash thoroughly until it contains no lumps and is moist throughout. It should fall in flakes when scattered with the hand.

When amyl acetate is used, it should be added to the other wet ingredients before the mixture is poured over the bran.

CAUTION

Poisoned-bran mash scattered in flakes will never be picked up by livestock in sufficient quantity to cause trouble, but if it falls in lumps animals may eat it with disastrous results. Farm animals have been poisoned by uncovering and eating left-over grasshopper bait that had been buried months before, in straw stacks and in the ground. Unused poisoned-bran mash should either be scattered thinly and evenly over the ground or burned in a stove or furnace. Barrels that have contained arsenic should also be burned. Great care should be taken in handling arsenic. Continued breathing of arsenic dust may seriously injure the lungs and if allowed to remain on the skin the dust may cause painful burns. Commercially mixed poisoned bran should be labeled "POISON," and every precaution taken to see that it is not accidentally fed to livestock in place of ordinary bran. It should never be left on wagons or trucks where horses or cattle can break open or lick the sacks containing it, and it should be stored in a building inaccessible to livestock and small children.

COMMERCIAL BAIT

Several commercial mixtures for the control of grasshoppers have been put on the market and are all right when honestly made. One commercial preparation is molasses and sodium arsenite already mixed in the proportion of 2 gallons of cane molasses to 2 quarts of sodium arsenite (4-pound material). Two and one-half gallons of this mixture added to 10 or 12 gallons of water is sufficient for 100 pounds of bran. Another mixture contains 80 pounds of bran, 15 pounds of cane molasses, and 5 pounds of crude arsenic mixed in stock-feed mills. The bran and arsenic are first mixed and then the hot molasses is added and the whole is thoroughly milled. The user has only to add water.

The advantages of the commercial over the home-mixed bait are that a much better mixture is obtained, dangers in the handling of arsenic by inexperienced persons are eliminated, and the product can be purchased ready-made from one concern, rather than assembled from several sources. This avoids delays which often prove disastrous.

Commercial baits should have at least the arsenic content required by the formula recommended in this bulletin.

METHODS OF DISTRIBUTION

The prepared mash should be thinly and evenly scattered over infested fields at the rate of 10 to 20 pounds (dry weight) per acre, according to the number of grasshoppers present. It is most commonly spread by hand. Every precaution should be taken to see that it falls apart into flakes. Casting it into the wind with a snap of the wrist will help to accomplish this. When large quantities of mash are to be distributed, scattering from the rear end of a wagon or truck is recommended. (Fig. 10.) This method permits two men to scatter at one time as the vehicle is driven slowly over the field. An end-gate seeder can be used, but must be carefully watched and not allowed to clog because of too rapid feeding. When large, uniformly infested areas difficult of access by wagon or truck are to be treated, scattering by airplane seems to be practicable. This is done by feeding the mash into the backwash from the propeller. From 75 to

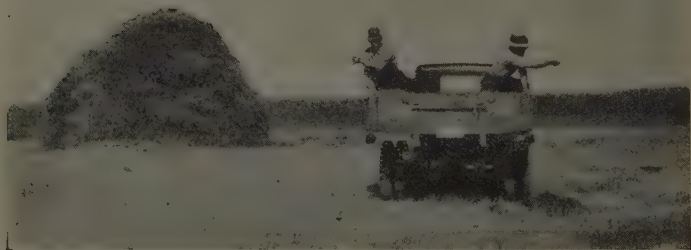


FIGURE 10.—Scattering poisoned bait from rear end of auto truck

100 acres per hour can be treated at an average cost of 10 to 15 cents per acre for use of the plane. The cost of scattering from wagons or trucks ranges from 10 to 20 cents per acre according to local conditions.

TIME OF DISTRIBUTING BAIT

The poisoned bait should be put out while the grasshoppers are on the ground, doing their first feeding of the day. This occurs as soon after sunrise as the temperature of the air reaches 70° to 80° F., usually between 6 and 10 o'clock in the morning. Exact temperatures at which maximum feeding occurs differ with the locality and the species. The bait should not be put out when the temperature is below 70° or above 85° F., or during cloudy or inclement weather. An exception to this rule can be made with grasshoppers that are migrating. Under such conditions they feed greedily on poisoned-bran mash scattered across the line of march, regardless of time and temperature.

Newly hatched grasshoppers usually remain for some time congregated on their hatching grounds. They should be poisoned while they are still confined to these places or before they have invaded

crops. It is important to realize that the use of poisoned bran is far more effective when young grasshoppers are concentrated along headlands than after they have increased in size and are dispersed over an entire field. Fighting grasshoppers before they attack or at the time they are first invading crops is one essential of a successful control campaign.

Grasshoppers do not die immediately after they have eaten the poisoned bait. The poison may require 24 hours or even longer to become fully effective. It usually makes grasshoppers sick within a few hours, however, and they do little damage after having eaten a fatal dose.

ADDITIONAL SUGGESTIONS FOR CONTROL

BARRIER STRIPS

When young grasshoppers are hatching in sod land adjacent to a crop likely to be attacked, their advance into the crop can be retarded by plowing a strip between the field and the sod land. If several deep furrows with sharp sides are plowed, the young hoppers will gather in them and can be killed by daily application of poisoned-bran mash.

TRAP STRIPS

Grasshoppers frequently are very abundant in alfalfa and other hay crops at the time of the first cutting. If narrow strips of such crops around the edges of the field and along irrigation ditches are left uncut, grasshoppers from all over the field will gather in them, and can be easily poisoned.

BURNING

At night, and even in the daytime during cool weather, grasshoppers seek protection. At such times great numbers of them can often be killed by scattering straw or weeds where the grasshoppers are congregated in the late afternoon and burning it at night after they have crawled into it and become sluggish.

POULTRY

Flocks of turkeys or chickens eat great numbers of grasshoppers and can sometimes be used to advantage in small local outbreaks.

CATCHING MACHINES

Various kinds of grasshopper-catching machines (fig. 11) have been largely used in the past, but they are no longer recommended unless it is desired to save the grasshoppers for poultry food or fish bait. The poisoned-bran mash is far more effective and is cheaper.

IMMUNE CROPS

Some of the sorghums, such as cane and Kafir corn, after reaching a height of 8 to 10 inches are practically immune to grasshopper attacks. They can be planted rather late in the season and provide valuable feed for livestock in areas where control measures have not been applied in time to save other forage crops.

ORGANIZING FOR GRASSHOPPER CONTROL

Where grasshoppers originate on a particular farm and menace only the crops on that farm, individual action is sufficient. If, however, they are present in such numbers that they are likely to move from one farm to another, community and often county-wide action becomes necessary. This can be secured only through proper organization, effective leadership, and adequate financial backing. Lacking any one of these essentials, a large-scale grasshopper campaign can not be successful. Unless a suitable organization already exists, one should be started. It may well be a farm bureau, farmers' union, community club, or other farmers' organization, headed by an active, efficient chairman. The following type of county organization is suggested:

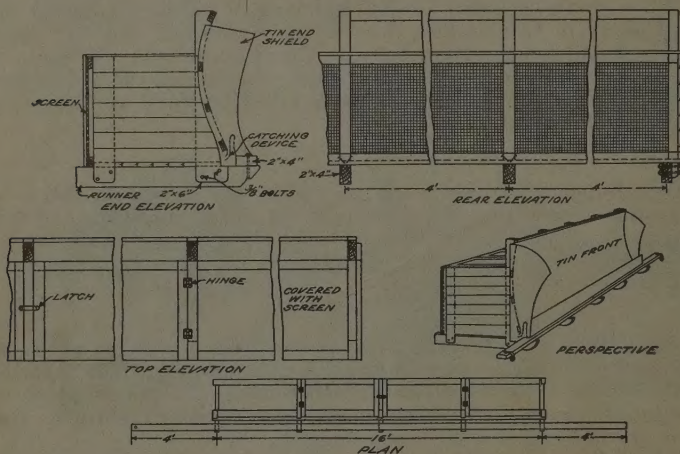


FIGURE 11.—Where it is desired to catch a quantity of grasshoppers to be used as poultry food, the grasshopper catcher is useful. Such a machine may be constructed according to the details shown in this illustration

(1) One executive, the county agricultural agent, if there is one, should be in charge of the campaign for the county. He should be responsible for funds expended, should purchase and apportion supplies, instruct community leaders in the methods to be employed, and make contact with State entomological leaders in order to obtain the latest information on grasshopper control.

(2) There should be community or township chairmen to act as supervisors under the direction of the county leader.

(3) Under these community chairmen there should be foremen of mixing and distributing centers to receive materials, to oversee mixing of materials, and to check out mixed materials to individual farmers and scattering crews.

(4) Finally, captains of scattering crews, men well acquainted with grasshopper conditions and familiar with the correct method of scattering poisoned-bran mash, should supervise the crews of men who scatter the bait in the field.

Farmers should cooperate and poison all grasshoppers regardless of where they are found. Cleaning up an entire community or township will not only save current crops but will render control measures the following year unnecessary. It should be emphasized that this is not a mere visionary ideal that can never be reached, but is an objective that has frequently been attained. A well-planned campaign, started early and pushed to completion before the grasshoppers are winged, will in most cases prevent serious crop losses; but if action is delayed in order to see what is going to happen or until the grasshoppers are doing serious damage and flying from one field to another, failure is certain.

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